Fun with Arcs and Sparks from Heinrich Hertz to Spacecraft Orbiting Jupiter

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Abstract

Modern spacecraft in the radiation belts of Jupiter, Earth and Saturn experience sufficient currents of charged particles to electrically charge insulation to the "breakdown" level, thence generating "electrostatic discharge" events. The discharge events are sufficiently large to produce temporary, and occasionally permanent, failures on spacecraft. After twenty years of research, the forms of the spacecraft arcs are becoming better characterized. For example, only this year have we become able to roughly (a-priori) predict the pulse rate generated by insulators in Earth's space environment. Furthermore, with sufficient study of the insulating material, one can monitor the pulse rate alone in order to determine the electric field in the insulator, or to determine the electrical conductivity in the insulator. The physics of the spacecraft discharges is rather complex, typically involving a dense gas phase inside the solid insulation and a diffuse gas phase in the adjacent vacuum. This talk will consist of a broad review of the variety of arcs and sparks experienced on spacecraft, and their relationships to arcs and sparks in ground technology. The arc-based instruments that were used by Heinrich Hertz circa 1887 to demonstrate the validity and practicality of Maxwell's Equations will be described in order to provide historic perspective on our spacecraft phenomena.

This talk is presented to the Department of Physics at Utah State University, Logan, Utah, 9 October 2001. It consists of the figures and data in the following papers that were presented at the 2001 ESTEC Conference on Spacecraft Charging Technology, Noordwijk, Netherlands, 23 April 2001.

Comparing CRRES Internal Discharge Monitor Results With Ground Tests And Published Guidelines (CL#01-0804)

Gas Discharge Phenomena In Spacecraft Discharge Pulses (CL#01-0593)

New Scaling Laws For Spacecraft Discharge Pulses (CL#01-0675)

Improved Testing Procedures For Spacecraft Discharge Pulses (CL#01-0676)